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| EXAMINER | |
|---|---|
| HUISMAN, DAVID J | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 2183 | |

DATE MAILED: 06/20/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/692,436 | SODANI, AVINASH | |
| | Examiner | Art Unit | |
| | David J. Huisman | 2183 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *22 October 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-24* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2,4-13,15-18,20,21,23 and 24* is/are rejected.

7)☒ Claim(s) *3,14,19 and 22* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *12 May 2004* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

1. Claims 1-24 have been examined.

### *Papers Submitted*

2. It is hereby acknowledged that the following papers have been received and placed of record in the file: Petition and Drawings as received on 5/12/2004.

### *Specification*

3. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed. The examiner also recommends incorporating the idea of having high and low-bandwidth tables.

4. The disclosure is objected to because of the following informalities:

- On page 10, line 19, remove the redundant "may be".

Appropriate correction is required.

### *Drawings*

5. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description:

- In paragraph [0025], applicant refers to 340 and 360, which are not illustrated.
- In paragraph [0035], applicant refers to 39, which is not illustrated.
- In paragraph [0036], applicant refers to 20, which is not illustrated.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

6. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference character(s) not mentioned in the description:

- In Fig.1, reference number 100 does not appear in the specification.
- In Fig.2, reference number 240 does not appear in the specification.
- In Fig.3, reference numbers 310, 312, 314, 316, 318, 320, 324, 330, 332, 334, 336, 362, 264, 366, and 368 do not appear in the specification.
- In Fig.4, reference numbers 410, 432, 434, and 440 do not appear in the specification.
- In Fig.5, reference numbers 30, 48, and 68 do not appear in the specification.

Corrected drawing sheets in compliance with 37 CFR 1.121(d), or amendment to the specification to add the reference character(s) in the description in compliance with 37 CFR 1.121(b) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet

submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

7. The drawings are objected to because of the following minor informalities:

- In Fig.1, please make the line coupling return stage 152 and BPU 126 an arrow.
- In Fig.2, the examiner believes that "4N" should be replaced with --3N--.
- In Fig.4, please insert a --2-- about bus 436 (similar to the "1" above bus 438).

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

***Claim Rejections - 35 USC § 102***

8. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

9. Claims 1-2 are rejected under 35 U.S.C. 102(b) as being anticipated by Yeager et al., U.S. Patent No. 5,758,112 (herein referred to as Yeager).

10. Referring to claim 1, Yeager has taught a processor comprising:

a) a first register alias table including a first number of read ports to translate a first set of logical register addresses to physical register addresses. See Fig.3, components 204 and 352 (floating-point rename table with 16 read ports).

b) a second register alias table including a second number of read ports to translate a second set of logical register addresses to physical register addresses, wherein said first number is greater than said second number. See Fig.3, components 206 and 354 (integer rename table with 12 read ports).

11. Referring to claim 2, Yeager has taught a processor as described in claim 1. Yeager has further taught that said first number is proportional to a third number of logical register addresses in said first set. See Fig.3 and column 8, lines 55-67, and note that a third number of addresses is 16 addresses (4 addresses (registers 358, 360, 362, and 364) in each of 4 parallel instructions). This is the reason 16 read ports are required (so that 4 instructions, each having 4 registers, may be renamed in parallel). Clearly, 1 set of 4 registers 4 read ports. So, it can be seen that 4

addresses is to 4 read ports, 8 addresses is to 8 read ports, 12 addresses is to 12 read ports, and 16 addresses is to 16 read ports. Consequently, the first number is proportional to a third number.

### *Claim Rejections - 35 USC § 103*

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

13. Claims 4-13, 15-18, 20-21, and 23-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yeager.

14. Referring to claim 4, Yeager has taught a processor as described in claim 1. Yeager has not taught a trace cache to supply a trace of micro-operations to said first register alias table and said second register alias table. However, Official Notice is taken that a trace cache and its advantages are well known and accepted in the art. Trace caches speed up the fetching process by caching instruction traces, which are sequences of decoded instructions. For example, a taken branch penalty is eliminated, since separate basic blocks appear contiguous in a trace. Also, since decoded instructions are stored in the trace cache, there is no need to decode them again next time they are fetched, which would save time. As a result, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Yeager to include a trace cache that provides instructions to the first and second RATs. And, one would be motivated to make such a combination to achieve time savings in the fetching/decoding process.

15. Referring to claim 5, Yeager has taught a processor as described in claim 4. The modified Yeager has further taught that said trace cache includes trace cache logic to build said trace limiting a third number of live-in and live-out logical registers to said second number. Each group of 4 instructions executed in parallel from a given trace can only have up to 4 live-out registers (4 read ports) and 8 live in-registers (8 read ports).

16. Referring to claim 6, Yeager has taught a method comprising:

a) storing translations from logical register addresses to physical register addresses in a first register alias table. See Fig.3, components 204 and 352 (floating-point rename table with 16 read ports).

b) storing translations from logical register addresses to physical register addresses in a second register alias table, where said second register alias table has fewer read ports than said first register alias table. See Fig.3, components 206 and 354 (integer rename table with 12 read ports).

c) Yeager has not explicitly taught that the translations stored in the first register alias table are frequently used translations while the translations stored in the second register alias table are less-frequently used translations. However, recall that Yeager's first table stores translations corresponding to floating-point operations while Yeager's second table stores translations corresponding to integer operations. Consequently, if there are more floating-point instructions in a given program than integer instructions, then the floating-point translations would be considered to be frequently used translations with respect to integer translations, which would be less-frequently used. Clearly, any given program could include more floating-point instructions than integer instructions. For instance, in signal processing (DSP) applications, floating-point

instructions are more common than integer instructions. As a result, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Yeager such that floating-point translations are more frequently used than integer translations, which would then result in the first table holding frequently used translations and the second table holding less-frequently used translations.

17. Referring to claim 7, Yeager has taught a method as described in claim 6. Yeager has further taught that said storing less-frequently used translations includes identifying said less-frequently used translations from a set of logical register addresses. Clearly, if integer register addresses and translations are encountered/identified, then the integer alias table will be used for storing.

18. Referring to claim 8, Yeager has taught a method as described in claim 7. Yeager has further taught that said identifying includes selecting infrequently used temporary registers. See column 14, lines 56-57. Basically, with renaming, the next free registers physical registers will be used in translation. These next free registers are infrequently used (less used) with respect to the previous free registers which have already been used. In addition, physical register contents are temporary (i.e., they are overwritten by new instructions).

19. Referring to claim 9, Yeager has taught a method as described in claim 8. Yeager has further taught that said infrequently used temporary registers are associated with a long micro-operation flow. All registers are associated with long programs (i.e., they are available for use by the long program).

20. Referring to claim 10, Yeager has taught a method as described in claim 7. Yeager has further taught that said identifying includes selecting control registers. All registers in the

system may be considered control registers because they control the data that is used during execution. For instance, say an addition instruction is of the form ADD R1, R2, R3. The numbers added will be controlled by R2 and R3.

21. Referring to claim 11, Yeager has taught a method as described in claim 10. Yeager has further taught that said identifying includes choosing registers used by a compiler. Column 1, lines 50-52, allude to the existence of a compiler, which translates high-level code into low-level code such as assembly/machine code. The compiler uses all registers in the translation of high-level to low-level code. For instance, Z = X+Y in high level code could be translated into:

```
LD R1 X          //load value of X into register R1
LD R2 Y          //load value of Y into register R2
ADD R3 R1 R2     //add R1 and R2 and store result in R3, which represents Z
```

So, it can be seen that with enough code to translate, registers are selected by the compiler in the translation process.

22. Referring to claim 12, Yeager has taught a method as described in claim 6. Yeager has not taught building a trace in a trace cache whose micro-operations require no more live-in registers and live-out registers using said second register alias table than a first number of read ports of said second register alias table. However, Official Notice is taken that a trace cache and its advantages are well known and accepted in the art. Trace caches speed up the fetching process by caching instruction traces, which are sequences of decoded instructions. For example, a taken branch penalty is eliminated, since separate basic blocks appear contiguous in a trace. Also, since decoded instructions are stored in the trace cache, there is no need to decode them again next time they are fetched, which would save time. As a result, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Yeager to include

a trace cache that provides instructions to the first and second RATs. And, one would be motivated to make such a combination to achieve time savings in the fetching/decoding process. In a given trace, each micro-operation will require at most 1 live-out register (Fig.3, component 372) and 2 live-in registers (components 368 and 370). Therefore, each micro-operation requires at most three registers, which is less than a number of read ports of the second table. Recall that the second table has 12 read ports.

23. Referring to claim 13, Yeager has taught a method as described in claim 12. The modified Yeager has further taught that said building includes permitting no more live-out registers using said second register alias table than a second number of write ports of said second register alias table. Again, any group of 4 instructions in a given trace cannot create more than 4 live-out registers because there are only 4 write ports.

24. Referring to claim 15, Yeager has taught an apparatus comprising:

a) means for storing translations from logical register addresses to physical register addresses in a first register alias table. See Fig.3, components 204 and 352 (floating-point rename table with 16 read ports).

b) means for storing translations from logical register addresses to physical register addresses in a second register alias table, where said second register alias table has fewer read ports than said first register alias table. See Fig.3, components 206 and 354 (integer rename table with 12 read ports).

c) Yeager has not explicitly taught that the translations stored in the first register alias table are frequently used translations while the translations stored in the second register alias table are less-frequently used translations. However, recall that Yeager's first table stores translations

corresponding to floating-point operations while Yeager's second table stores translations corresponding to integer operations. Consequently, if there are more floating-point instructions in a given program than integer instructions, then the floating-point translations would be considered to be frequently used translations with respect to integer translations, which would be less-frequently used. Clearly, any given program could include more floating-point instructions than integer instructions. For instance, in signal processing (DSP) applications, floating-point instructions are more common than integer instructions. As a result, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Yeager such that floating-point translations are more frequently used than integer translations, which would then result in the first table holding frequently used translations and the second table holding less-frequently used translations.

25. Referring to claim 16, Yeager has taught an apparatus as described in claim 15. Yeager has further taught that said means for storing less-frequently used translations includes identifying said less-frequently used translations from a set of logical register addresses. Clearly, if integer register addresses and translations are encountered/identified, then the integer alias table will be used for storing.

26. Referring to claim 17, Yeager has taught an apparatus as described in claim 15. Yeager has not taught means for building a trace in a trace cache whose micro-operations require no more live-in registers and live-out registers using said second register alias table than a first number of read ports of said second register alias table. However, Official Notice is taken that a trace cache and its advantages are well known and accepted in the art. Trace caches speed up the fetching process by caching instruction traces, which are sequences of decoded instructions. For

example, a taken branch penalty is eliminated, since separate basic blocks appear contiguous in a trace. Also, since decoded instructions are stored in the trace cache, there is no need to decode them again next time they are fetched, which would save time. As a result, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Yeager to include a trace cache that provides instructions to the first and second RATs. And, one would be motivated to make such a combination to achieve time savings in the fetching/decoding process. In a given trace, each micro-operation will require at most 1 live-out register (Fig.3, component 372) and 2 live-in registers (components 368 and 370). Therefore, each micro-operation requires at most three registers, which is less than a number of read ports of the second table. Recall that the second table has 12 read ports.

27. Referring to claim 18, Yeager has taught an apparatus as described in claim 17. The modified Yeager has further taught that said building includes permitting no more live-out registers using said second register alias table than a second number of write ports of said second register alias table. Again, any group of 4 instructions in a given trace cannot create more than 4 live-out registers because there are only 4 write ports.

28. Referring to claim 20, Yeager has taught a system comprising:

a) a processor including a first register alias table including a first number of read ports to translate a first set of logical register addresses to physical register addresses. See Fig.3, components 204 and 352 (floating-point rename table with 16 read ports).

b) a second register alias table including a second number of read ports to translate a second set of logical register addresses to physical register addresses, wherein said first number is greater

than said second number. See Fig.3, components 206 and 354 (integer rename table with 12 read ports).

c) Yeager has not explicitly taught an audio input/output device and an interface to couple said processor to said audio input/output device. However, Official Notice is taken that interfacing audio devices to a processor is well known and accepted in the art. That is processors are known to be coupled to devices such as speakers and microphones, which allow the processor to produce sounds and process sounds, such as speech. This allows for additional interaction between the user and machine. As a result, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Yeager to include an audio I/O device which is interfaced to the processor.

29. Referring to claim 21, Yeager has taught a system as described in claim 20. Yeager has further taught that said first number is proportional to a third number of logical register addresses in said first set. See Fig.3 and column 8, lines 55-67, and note that a third number of addresses is 16 addresses (4 addresses (registers 358, 360, 362, and 364) in each of 4 parallel instructions). This is the reason 16 read ports are required (so that 4 instructions, each having 4 registers, may be renamed in parallel). Clearly, 1 set of 4 registers 4 read ports. So, it can be seen that 4 addresses is to 4 read ports, 8 addresses is to 8 read ports, 12 addresses is to 12 read ports, and 16 addresses is to 16 read ports. Consequently, the first number is proportional to a third number.

30. Referring to claim 23, Yeager has taught a system as described in claim 20. Yeager has not taught a trace cache to supply a trace of micro-operations to said first register alias table and said second register alias table. However, Official Notice is taken that a trace cache and its advantages are well known and accepted in the art. Trace caches speed up the fetching process

by caching instruction traces, which are sequences of decoded instructions. For example, a taken branch penalty is eliminated, since separate basic blocks appear contiguous in a trace. Also, since decoded instructions are stored in the trace cache, there is no need to decode them again next time they are fetched, which would save time. As a result, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Yeager to include a trace cache that provides instructions to the first and second RATs. And, one would be motivated to make such a combination to achieve time savings in the fetching/decoding process.

31. Referring to claim 24, Yeager has taught a system as described in claim 23. The modified Yeager has further taught that said trace cache includes trace cache logic to build said trace limiting a third number of live-in and live-out logical registers to said second number. Each group of 4 instructions executed in parallel from a given trace can only have up to 4 live-out registers (4 read ports) and 8 live in-registers (8 read ports).

### *Allowable Subject Matter*

32. Claims 3, 14, 19, and 22 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

### *Conclusion*

33. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Applicant is reminded that in amending in response to a rejection of claims, the patentable novelty must be clearly shown in view of the state of the art disclosed by the

references cited and the objections made. Applicant must also show how the amendments avoid such references and objections. See 37 CFR § 1.111(c).

Chamdani et al., U.S. Patent No. 6,112,019, has taught a system which includes multiple rename tables with different port amounts.

Karim, U.S. Patent No. 5,481,683, has taught a superscalar computer architecture using remand and recycled general purpose register to manage out-of-order execution of instructions.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to David J. Huisman whose telephone number is (571) 272-4168. The examiner can normally be reached on Monday-Friday (8:00-4:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie Chan can be reached on (571) 272-4162. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

DJH

David J. Huisman
June 9, 2006

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